

Regional Assessment Of Arctic Vegetation Productivity And Soil Respiration Environmental Controls Using MODIS And AMSR-E: A New Approach For Satellite Monitoring Of Pan-Arctic Terrestrial Net CO₂ Exchange

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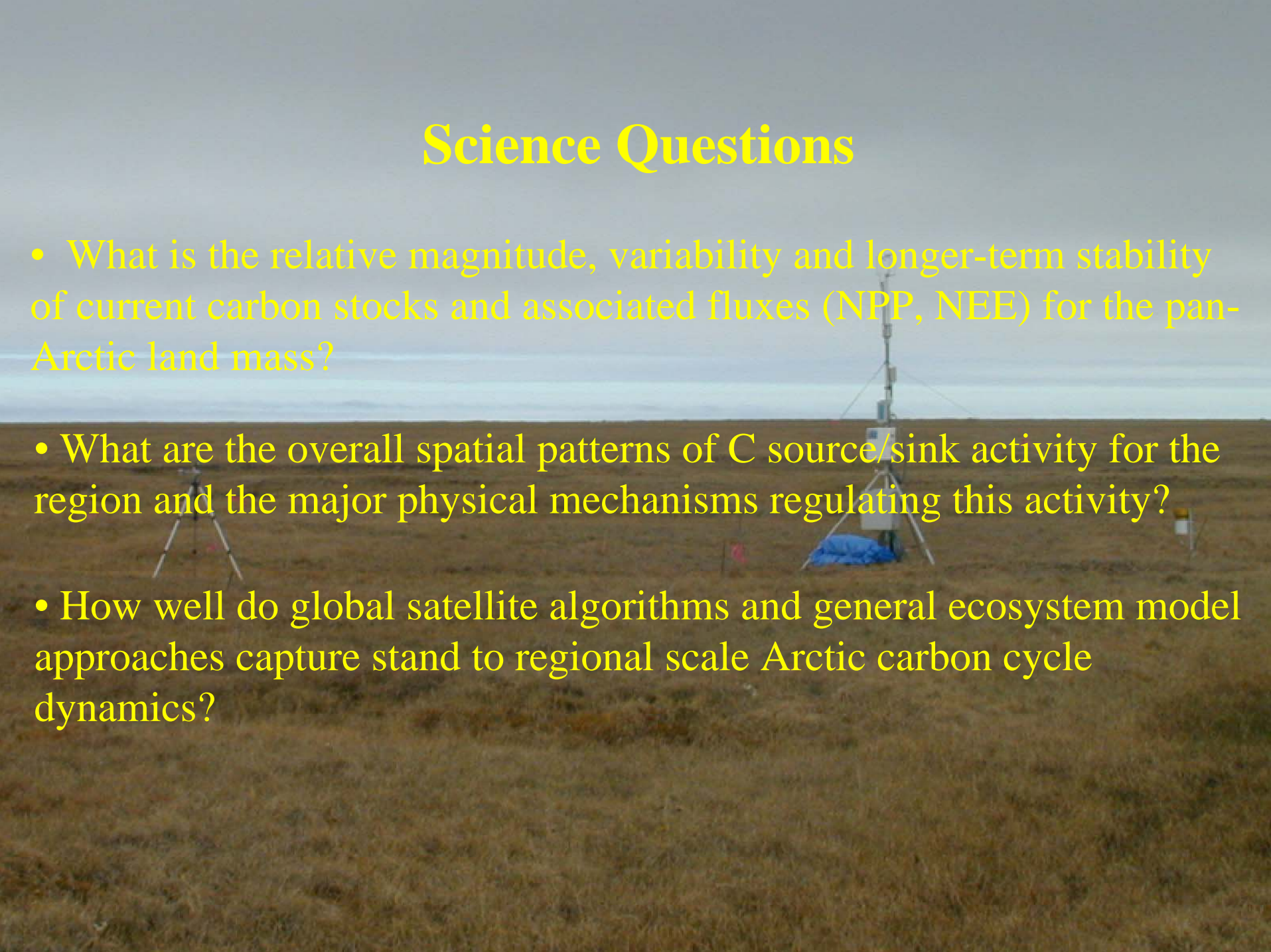
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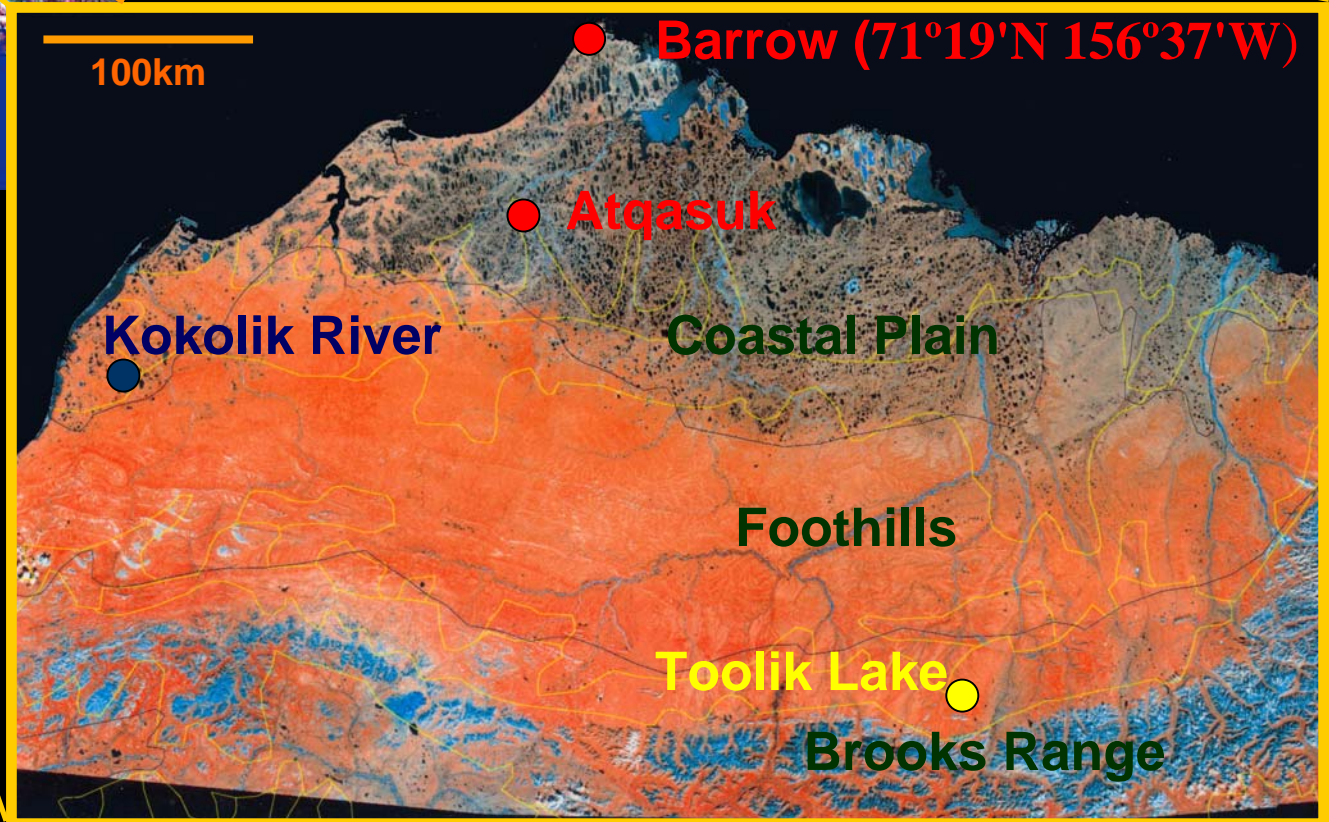
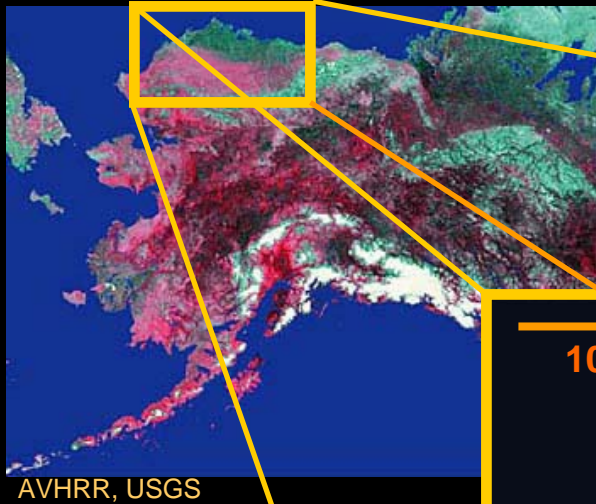
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Science Questions

- What is the relative magnitude, variability and longer-term stability of current carbon stocks and associated fluxes (NPP, NEE) for the pan-Arctic land mass?
- What are the overall spatial patterns of C source/sink activity for the region and the major physical mechanisms regulating this activity?
- How well do global satellite algorithms and general ecosystem model approaches capture stand to regional scale Arctic carbon cycle dynamics?



Alaska North Slope Study Region

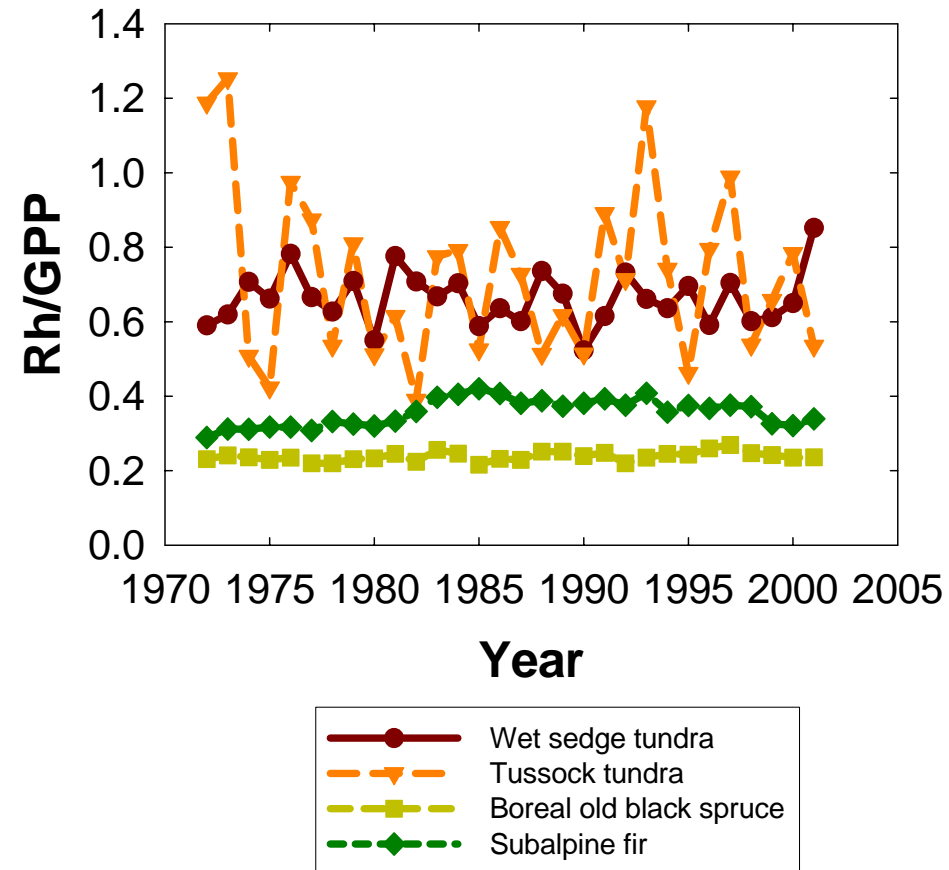
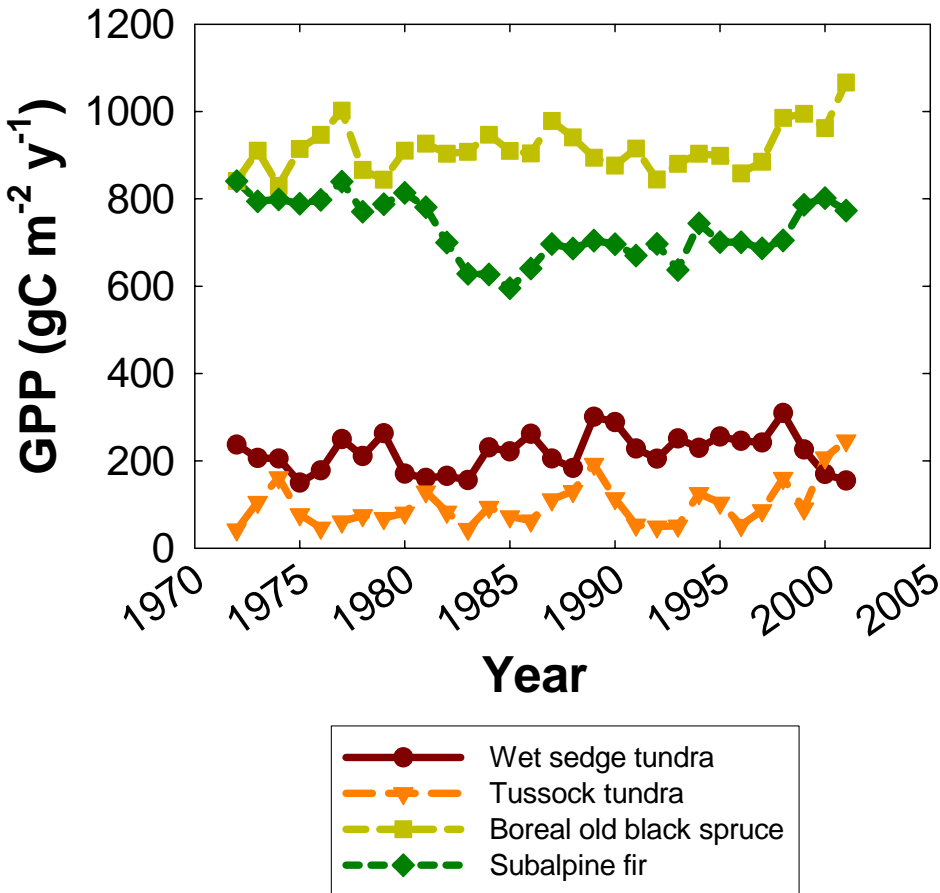


The Arctic Soil Carbon Reservoir

- > 90% total carbon of Tundra ecosystems is below ground
- Arctic SOC storage represents 14-16% (~390Pg) of global soil C pool
- Arctic SOC storage strongly regulated by soil water and temperature

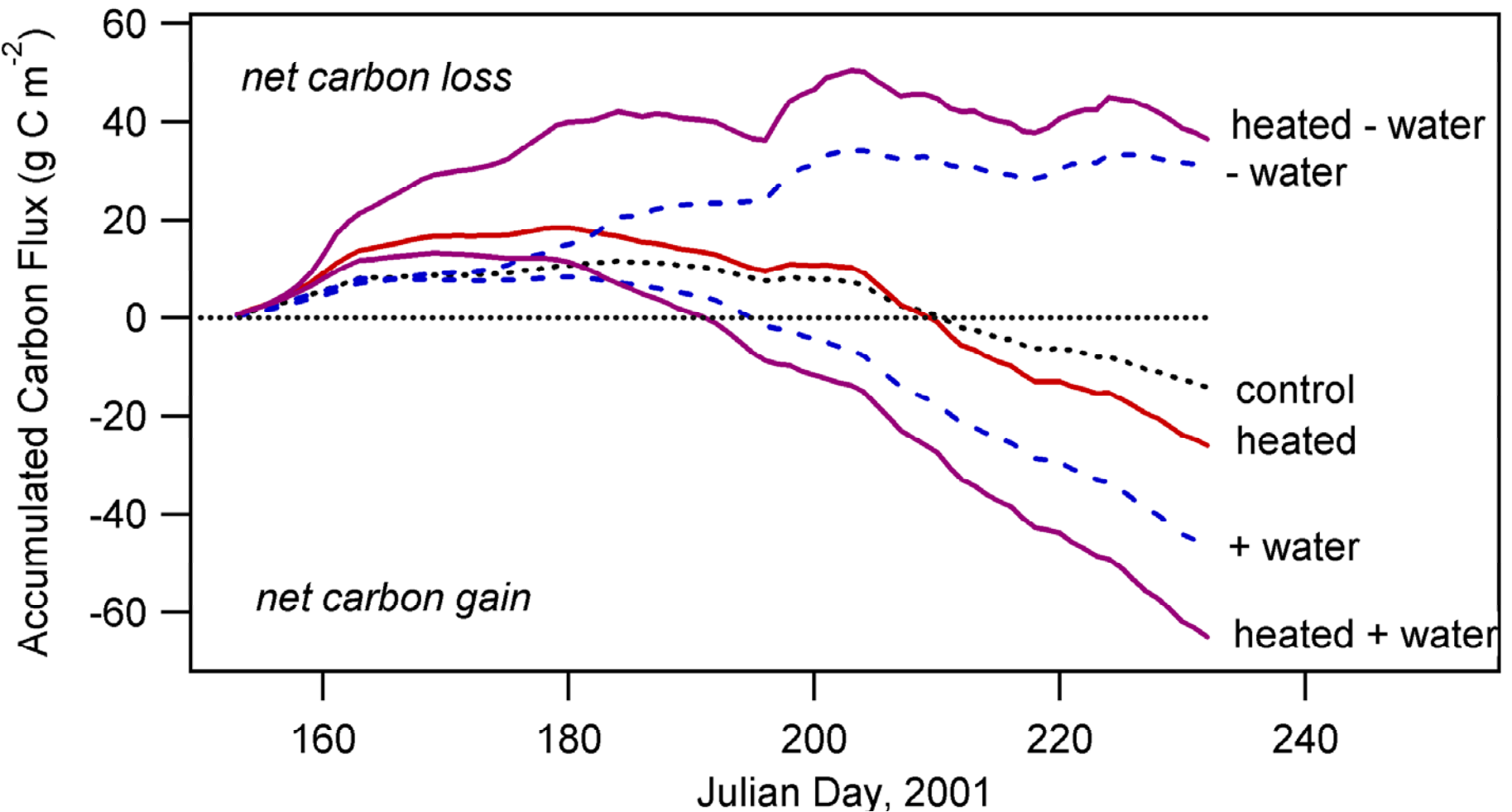


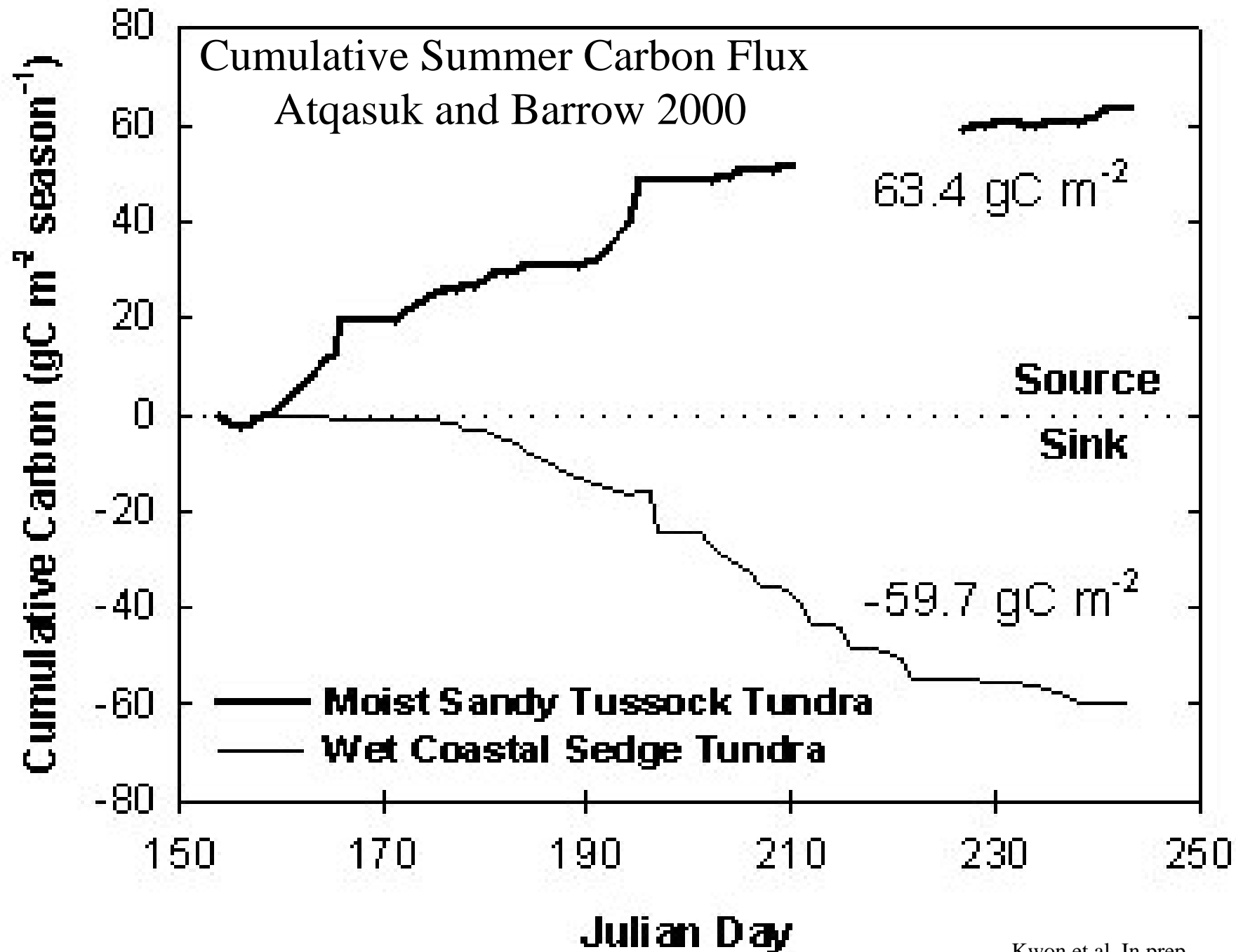
Estimated Gross Primary Production (GPP) and Soil Heterotrophic Respiration (Rh) for Boreal and Arctic Sites



- $\text{NPP} = \text{GPP} - \text{R}_{\text{aut}}$
- $\text{Net CO}_2 \text{ exchange (NEE)} = \text{NPP} - \text{Rh}$

Soil Temperature and Moisture Effects on Tundra CO₂ Exchange (Chamber manipulation experiment, Alaska North Slope)



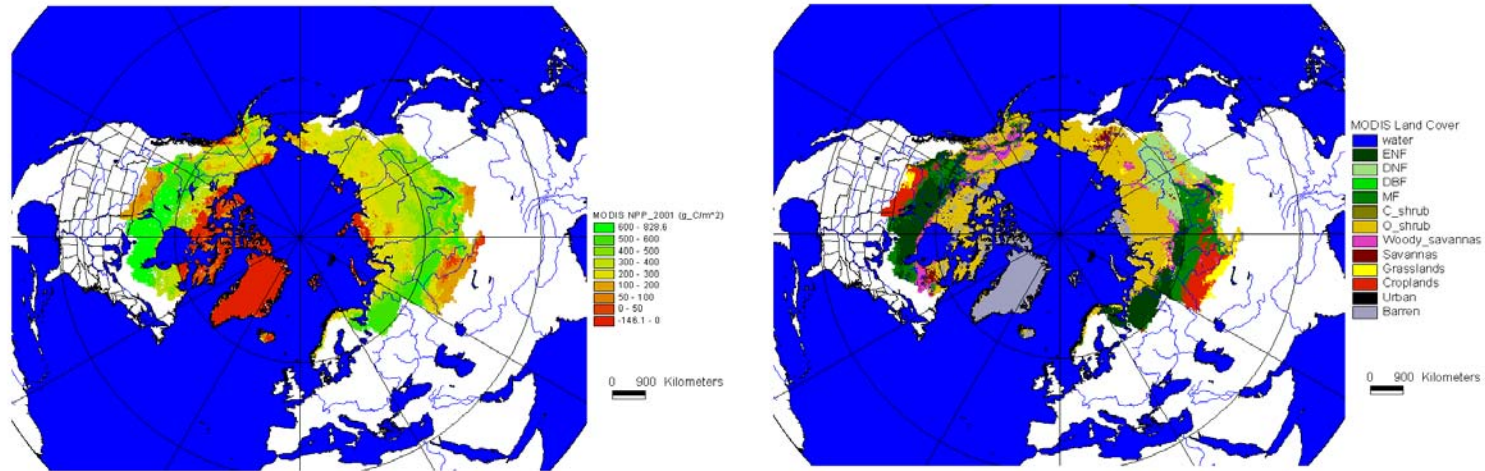


Approach

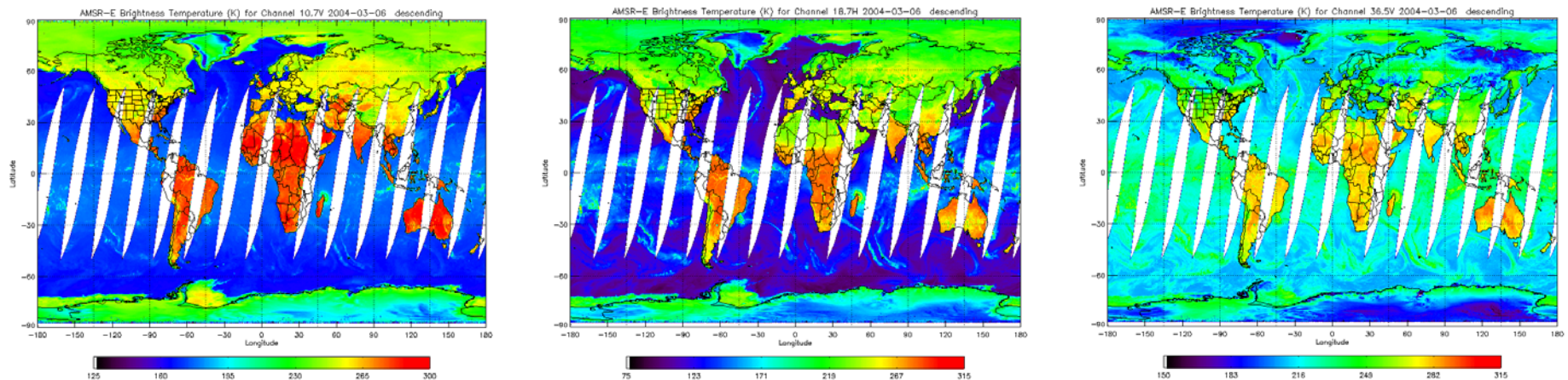
- Apply global satellite remote sensing (MODIS and AMSR-E) for quantifying regional patterns, seasonal dynamics and annual variations in Arctic vegetation structure (LAI) and productivity (GPP, NPP), heterotrophic respiration (R_h) and net CO_2 exchange (NEE).
- Spatial and temporal scaling and interpretation among surface network biophysical measurements (e.g., chambers, flux towers), aircraft (Sky-Arrow) and satellite based measurements, and ecosystem modeling.
- Exploration and development of alternative remote sensing technologies (e.g., HYDROS) for better regional assessment and monitoring of net C fluxes and associated driving processes.

Aqua Satellite Remote Sensing Information for Deriving Tundra Net CO₂ exchange (NEE)

MODIS: Vegetation productivity (NPP) and structure (LAI, Landcover), Ts (LST)



AMSR-E: Environmental controls to soil respiration, Rh (10.7, 18.7, 37 GHz; Ts, F/T and M_v)



An Approach for Deriving Arctic NEE from Satellite Remote Sensing

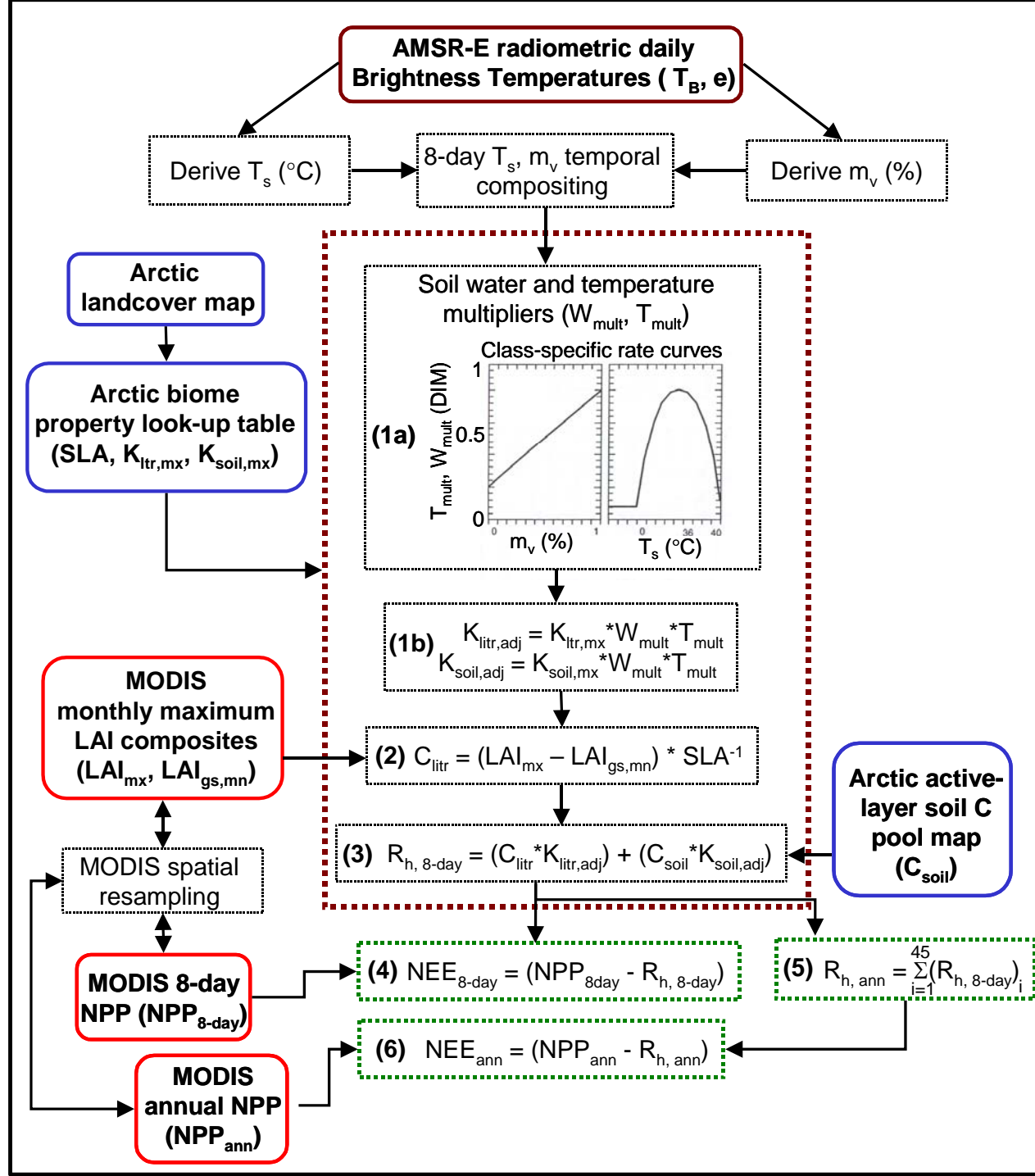
Terra/Aqua-MODIS:

- GPP, NPP
- Land cover, LAI
- T_{surface}

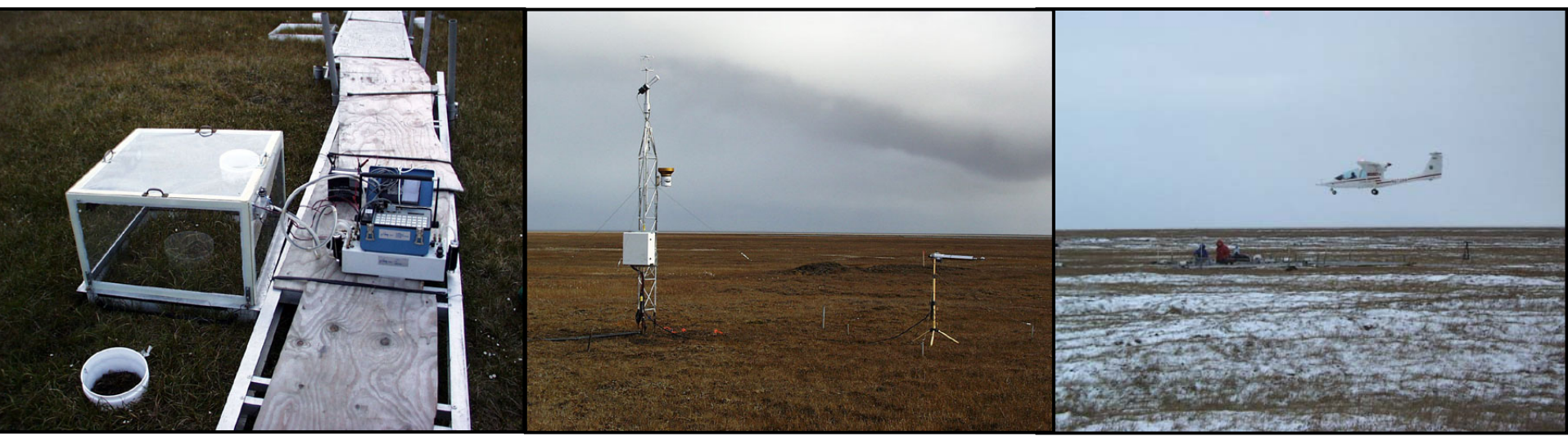
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Aqua-AMSR-E:

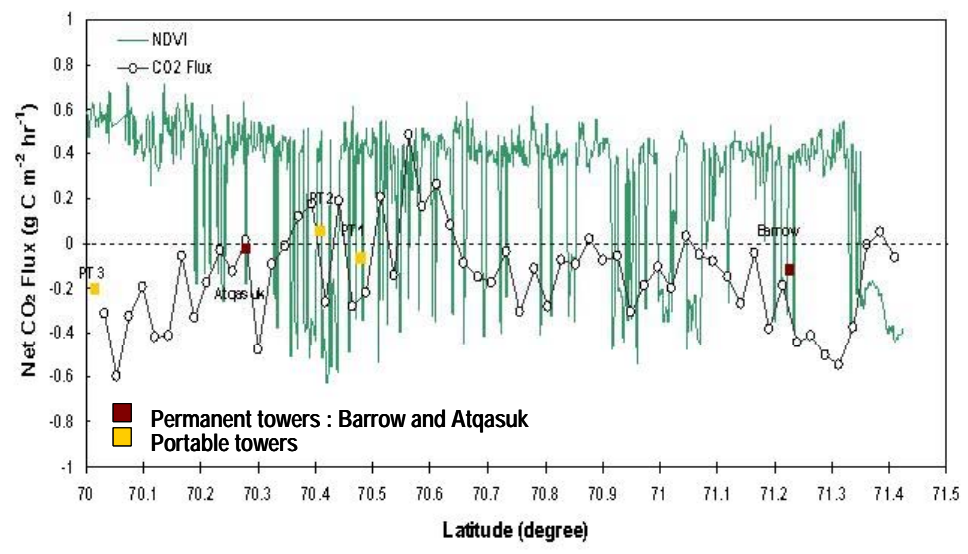
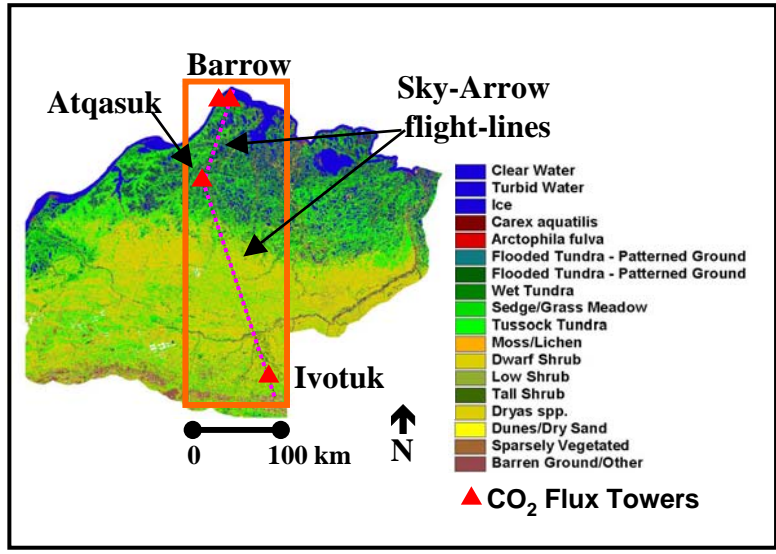
- T_{surface}
- Surface moisture
- Freeze-thaw state
- R_h



Multiscale Measurements for Satellite Algorithm Development and Verification



Aircraft measurement: July 12, 2001 ; tower measurements: around July 12, 2002



Anticipated Results

- Comprehensive satellite-based information for Arctic C-cycle assessment, monitoring:
 - Daily AMSR-E based Ts, Mv, F/T maps;
 - Weekly/annual Rh, NEE maps
 - Regional maps of CO₂ source/sink patterns and anomalies
- Independent validation source for regional experiments (NACP) and future satellite missions (OCO, HYDROS)
- Better knowledge of Arctic C-cycle dynamics and global feedbacks:
 - Linkages between plant, hydrologic and soil carbon processes
 - Current status, variability and future stability of Arctic SOC pool